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The use of chipboard

In spite of the unfavourable economic climate prevailing in the UK in recent years, the annual volume of chipboard used continues to increase rapidly; the annual consumption of chipboard on a weight basis now far outstrips that of both plywood and fibre building board. Since 1960 the annual weight of chipboard used in the UK has increased twenty-fold (Figure 1). During this time the quality of the material has improved significantly and it is now being used in a far wider range of applications. About 35 to 40 per cent of the UK consumption of chipboard is used in the construction industry; there is a wide scope for its use provided the appropriate grade is used and due regard is paid to the Codes of Practice and British Standard recommendations. Limitations in performance of the basic grade have been recognised by the development of grades with superior performance using a wide range of adhesives. It is to everyone's advantage to specify and use only the most appropriate type for a particular end use and this digest discusses the views of the Princes Risborough Laboratory of the Building Research Establishment on the use of chipboard in different aspects of building and construction.

Production

Chipboard is manufactured primarily, though not exclusively, from small, thin softwood chips bonded together under heat and pressure using a synthetic resin comprising about 8 per cent of the dry weight of the board. Coarser chips are utilised in the centre of the board while smaller and thinner chips are used in the surface layers; the geometry of the chips, the relative proportion of resin in the central and skin layers, and the relative thickness of these layers is adjusted to produce boards best suited for the requirements of a particular end use.

Several different types of synthetic resins are used, though about 95 per cent of the chipboard used in the UK is produced using urea formaldehyde (UF) resin. A number of manufacturers throughout Europe are producing chipboard incorporating melamine-urea formaldehyde (MF/UF): this is basically a urea formaldehyde resin in which about 40 per cent of the urea has been replaced by melamine. A few manufacturers, most of them in Germany, produce chipboard bonded with phenol formaldehyde (PF) resin.

Two other types of wood-based particle board are to be found on the UK market at present. The first is waferboard, produced from very large thin flakes of poplar wood bonded together with about 3 per cent by weight of phenol formaldehyde; the second is wood-cement particle board comprising about 25 per cent by weight of softwood chips, similar to those used for chipboard, bonded together with cement.

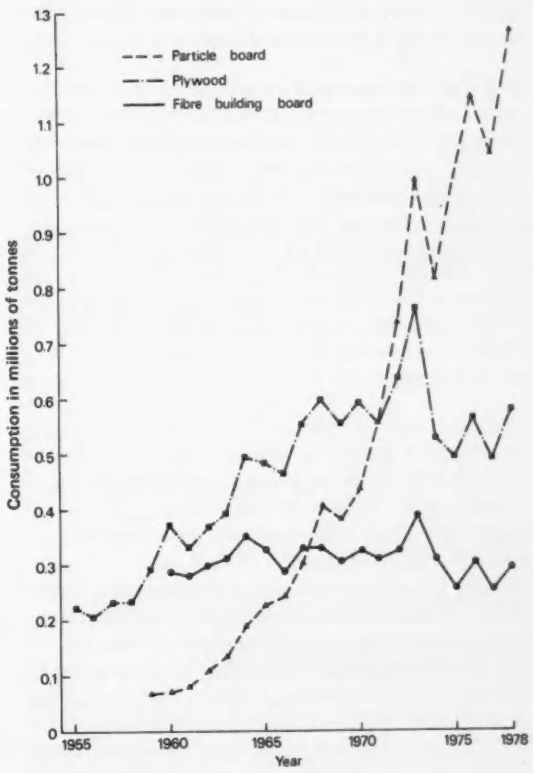

Fig 1 UK consumption of board materials

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Technical enquiries arising from this Digest should be directed to Building Research Advisory Service at the above address.

Performance

The suitability of chipboard for a particular end use depends primarily on its long-term performance; although initial levels of strength and stiffness need to be appropriate to the use, it is also important that these property levels are maintained particularly where adverse conditions may develop in service. One of the most significant factors affecting the performance of particle board is moisture. High moisture conditions may be encountered in kitchens, bathrooms and roofs in the form of high relative humidity, marked alternation in relative humidity, and actual soaking; the effect of these is accentuated with increasing temperature and time.

The reaction of particle boards to such adverse moisture conditions is noticeably different as Figure 2 demonstrates and depends on the type of resin used in the board's construction. Commercial UF chipboard subjected to a relative humidity of 87 per cent at 27°C for a period of 25 weeks and reconditioned to 65 per cent prior to testing possesses only 66 per cent of its initial strength (in tension perpendicular to the board face): the reduction in bending strength and stiffness is similar while the thickness of the board is found to increase by 9 per cent. The corresponding reduction in tensile perpendicular strength for commercial MF/UF and PF chipboards is 0 and 4 per cent respectively, both boards showing an increase in thickness of 5 per cent.

The basic difference in performance, therefore, between the UF CHIPBOARDS AND THE MF/UF and PF boards is that the latter two are capable of almost full strength recovery on drying following a period of wetting-up, while the UF boards show very little recovery; moreover the strength loss of UF boards increases markedly at elevated temperature.

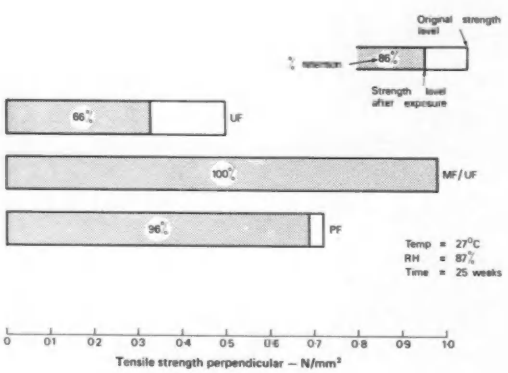

Fig 2 Retention of tensile strength of particle board following exposure to high humidity

In addition to physical deterioration, high moisture conditions can also induce fungal degrade. Unless a fungicide is incorporated during manufacture, wood-based particle board is no more durable than the wood species from which it is made. This must be taken into consideration when using boards with improved resistance to moisture under conditions of prolonged wetting. BS5268: Part 5 gives general guidance on the risk of biodegrade in timber in various structural situations and this advice can be extended to chipboard, which should be regarded as having no natural durability of its own.

Experience with wood-cement particle board, particularly in wet situations, is somewhat limited, but the indications are that its performance in terms of loss in strength on wetting and drying is at least as good as the MF/UF boards while its dimensional stability is far superior.

Specification

BS5669 defines the property levels to satisfy the requirements for three basic grades of chipboard (types I, II and III): it also provides recommendations for the type of chipboard to be used in different end uses.

Concern has been expressed over the importation and use of chipboard not conforming with the requirements of BS 5669. Considerable volumes of such chipboard are imported, much of it causing problems at a later stage bringing the usage of chipboard into disrepute. Although financially attractive in the short-term the use of non-standard material is to be strongly deprecated and it is in the long-term interests of the architect and builder to specify and ensure that he receives chipboard conforming to the British Standard. All such boards must be stamped with the number of the standard and colour coded according to grade as specified in BS 5669, unless prior agreement has been reached between one particular manufacturer and purchaser.

More assurance is offered to the consumer if the chipboard is stamped with the BSI Kitemark. This means that regular monitoring of the property levels of the manufactured chipboard is carried out by the British Standards Institution.

Application

Within the construction industry the two principal uses of chipboard are in flooring and roofing, each of which calls for particular requirements of the board.

Flooring

Chipboard is particularly attractive as a flooring material because of its favourable installed cost and flat surface compared with tongued and grooved board flooring: it has found widespread acceptance in both suspended and floating floor systems.

Flooring grade board (type II and II/III of BS 5669) has higher strength, stiffness and impact resistance than the general purpose board (type I, BS 5669) and should be used for all domestic floors as required in the proposed revision to CP 201 and the specified requirements of the National Housebuilders' Council. All too frequently general purpose board is used for flooring, sometimes resembling a flooring grade board by having its edges tongued and grooved. There are many examples where non-flooring grade chipboard has failed in service, an occurrence which is both expensive to the house owner and destructive to the reputation of chipboard; both specifiers and purchasers should ensure that they order and receive a true flooring grade board conforming with the requirements of BS 5669, type II, *and marked accordingly.*

While UF bonded flooring grade chipboard (type II) is adequate for use in those situations where there is a *guaranteed* absence of moisture throughout the life of the building, it is entirely unsuitable, unprotected, for flooring where there is a risk of moisture uptake arising from leakage or spillage of water, as can occur in kitchens, bathrooms and toilets. A survey of the moisture contents occurring in Local Authority housing in Scotland, recently published by the Princes Risborough Laboratory, indicated that in kitchens 48 per cent of the readings taken of the wood-boarded floor adjacent to the sink were greater than 20 per cent, while in bathrooms, 66 per cent of the readings adjacent to the toilet were greater than 20 per cent and 47 per cent greater than 25 per cent. A limited number of houses in the survey had chipboard floors, but the values obtained showed the same general trend. Under conditions such as these UF chipboard deteriorates rapidly, necessitating early repairs as noted in the survey. Another survey, this time carried out by the Agrement Board, has also highlighted kitchen and bathroom floors as high hazard areas for UF chipboard flooring.

Two solutions are available assuming that both leakage and spillage of water are inevitable. The first involves tanking the floor, a system practised in Scandinavia. A continuous plastics sheet covers the floors and extends up the wall for a few inches: all service pipes must be taken through the wall, or fitted with a watertight collar if passed through the floor. The impression prevails that vinyl floor tiles constitute an effective method of sealing the chipboard floor from water; however this view is mistaken for experience has shown that tiles can actually aggravate the situation because water penetrates between them and is absorbed by the board, the tile then preventing subsequent drying out of the board.

An alternative solution to tanking is to use a flooring grade chipboard incorporating either an MF/UF or a PF adhesive (type II/III of BS 5669). However, it must be appreciated that even using these types of board, prolonged wetting can result in fungal attack of the wood, with resultant loss in strength, unless the board incorporates a fungicide, a practice which is adopted by only a few manufacturers.

Treatment of UF boards with a wax coating at time of manufacture, or with a polyurethane-type finish after installation, will considerably reduce the rate of uptake of moisture by the board, though it certainly will not prevent it. Thus, while the long-term absorption of moisture is still a problem, these coatings certainly reduce and possibly almost eliminate the deteriorating effect of alternating humidity on UF-bonded chipboard provided any cut faces are effectively resealed: equally as important is the opportunity they afford of mopping up spilled water before it is absorbed into the chipboard. The factory-added wax coating provides protection during transportation, storage and installation, and it renders UF boards suitable for platform flooring in timber frame construction.

Many examples of failed chipboard ground-flooring arise from condensation caused by inadequate ventilation of the air space below suspended floors, inadequate insulation under floating floors, the absence of a vapour barrier, and most frequently of all, the failure to allow the concrete solum or screed time to dry out before laying the chipboard. Such problems will be avoided by effective design, or construction which prevents prolonged wetting of the boards. UF-bonded chipboard certainly will not withstand such conditions, and it is likely that even MF/UF and PF chipboards would be adversely affected unless protected by a fungicide.

Roofing

Pitched roofs Urea formaldehyde chipboard has been used as sarking on pitched roofs in Scotland for many years and until recently has performed the task satisfactorily. However, rising energy costs have encouraged the home owner to increase the amount of insulation in his loft and this in turn can be expected to result in higher moisture content levels in the roof timbers and boarding. A number of cases have recently been reported of extensive mould growth on the underside of sarking in domestic buildings; the presence of moulds is indicative of moisture content levels sufficient to ensure degrade of the UF-based boards as noted earlier.

Because the extent of quantitative data on recent trends in moisture contents in sarking is limited, no firm recommendation against the use of UF chipboard for sarking can be made; however, it is considered necessary to warn architects and builders of possible future problems and to bring to their attention the much higher degree of assurance offered by MF/UF and certain PF bonded chipboards (type III BS 5669). It is too early to say how the wax-coated UF bonded chipboards will perform under these conditions; certainly the rate of moisture uptake is much reduced and it is possible that the moisture content will not attain its maximum winter level before drying out commences in the spring.

Sarking is frequently subject to rain after installation and prior to tiling; where the exposure is greater than an hour or two considerable irreversible deterioration of UF chipboard can occur. The can be overcome by using a UF board with protective coating eg wax or

bitumen (prefelted), provided newly-cut edges of the wax-surfaced board are effectively resealed and the joints of prefelted boards are taped. Alternatively, as recommended above, an MF/UF or PF bonded chipboard can be used.

Flat roofs While there are many chipboard decks which have given very good service there are, nevertheless, an appreciable number of failures as indicated by the number of enquiries received by the Building Research Advisory Service.

Disintegration or severe distortion of chipboard decks can arise from moisture ingress due either to failure of the waterproof membrane or to poor workmanship (especially on the roof detailing), or to the effects of the condensation of water vapour originating in the rooms below. When wetting occurs, the effect is likely to be prolonged, resulting in deterioration of UF bonded boards: this effect is aggravated by elevated temperature, a frequent condition in flat roof structures in the summer months.

The failure of a chipboard deck is the eventual outcome of poor roof design or workmanship in installation and while every effort should be made to redress these deficiencies through education and training, experience suggests that only limited improvement will actually be achieved and that moisture ingress and condensation will unfortunately continue and even increase in extent. Under the arduous conditions which often develop in a flat roof deck the continued use of UF chipboard (types I and II, BS 5669) coated or uncoated cannot be recommended. In order to provide assurance on the performance of chipboard in flat roof decks, the choice of board must be restricted to those bonded together using either MF/UF or PF resins and preferably incorporating a fungicide. This should ensure that both the adhesive and the wood are protected against the effects of high moisture contents.

Not all MF/UF and PF chipboards incorporate fungicides; however, even in their absence, the performance of the board is still considerably superior to the UF-bonded board. Provided wetting-up is noticed at an early stage and action taken to promote drying, the MF/UF or PF board will retain its strength when dried out, whereas the UF board under the same circumstances will permanently lose much of its strength and will have to be replaced.

So far, wood-cement particle board has not been used for decking but it appears to have considerable potential provided allowances in design are made for its increased weight and slightly lower impact resistance and bending strength. Not only is it much more dimensionally stable than resin-bonded chipboard, thereby reducing the amount of stress on the felt, but it is also very durable under wet conditions: strength in the wet state is good and the high alkalinity present will deter the growth of fungi under wet conditions.

Other applications

Chipboard is frequently used for industrial shelving. In view of the loads involved and the tendency for chipboard to creep at a faster rate than solid wood, flooring grade chipboard (type II, BS 5669) should be used and must be supported at frequent intervals. Where the relative humidity is likely to exceed 65 per cent, type II/III should be employed.

Considerable interest is being shown at present in the use of chipboard for concrete formwork, primarily on account of its competitive cost. Flooring grade chipboard (types II and II/III) coated with either melamine or phenolic films, or treated with wax or polyurethane have been shown to give good service, though some care has to be exercised to prevent damage to the corners.

Chipboard is also suitable as a lining for internal partitions in a house, though its application is limited because of the lower cost of plasterboard. In the design of public buildings, however, wood-cement particle board has particular appeal because it has a high degree of inherent resistance to both fire and moisture.

British Standards

BS 5268 The structural use of timber
Part 5: Preservative treatments for constructional timber

BS 5669:1979 Wood chipboard and methods of test for particle board

BS CP 201 Flooring of wood and wood products
Part 2: 1972 Wood flooring (board, strip, block and mosaic)

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